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# A THEORY OF PROCESS MODELING IMPACT

*ICIS2014 Doctoral Consortium*

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## **Abstract**

*Process modeling – the design and use of graphical documentations of an organization's business processes – is a key method to document and use information about the operations of businesses. Still, despite current interest in process modeling, this research area faces essential challenges. Key unanswered questions concern the impact of process modeling in organizational practice, and the mechanisms through which impacts are developed. To answer these questions and to provide a better understanding of process modeling impact, I turn to the concept of affordances. Affordances describe the possibilities for goal-oriented action that a technical object offers to a user. This notion has received growing attention from IS researchers. The purpose of my research is to further develop the IS discipline's understanding of affordances and impacts from information objects, such as process models used by analysts for information systems analysis and design. Specifically, I seek to extend existing theory on the emergence, perception and actualization of affordances. I develop a research model that describes the process by which affordances emerge between an individual and an object, how affordances are perceived, and how they are actualized by the individual. The proposed model also explains the role of available information for the individual, and the influence of perceived actualization effort. I operationalize and test this research model empirically, using a full-cycle, mixed methods study consisting of case study and experiment.*

**Keywords:** Business process modeling, Impact, Affordances, Theory building, Mixed methods

## 1. Introduction

Process modeling – the design and use of graphical documentations of an organization's business processes – is an important activity in organizational and systems design (Ould 1995). Process models are often used for their ability to specify actors, events, tasks, data, and their relationships (Curtis et al. 1992). Process modeling research has been increasing in line with a rising prominence of process modeling activities in industry (Mendling et al. 2009). This growing significance requires an understanding of the actual and potential impacts from process modeling. In my PhD study, I propose and examine a theory to explain which impacts arise from process modeling, and how.

This is the first study to examine the types and forms of impacts that are generated through process model use in organizations. My first research question is:

**RQ 1:** *What are the impacts of process model use?*

Second, I wish to learn the mechanisms that generate impacts. This leads to my next question:

**RQ 2:** *What are the mechanisms that lead to impacts of process model use?*

To address RQ 2, I considered multiple theoretical perspectives (namely, affordances, adaptive structuration, task-technology fit, IS success, boundary objects, and ontology) that might suit a process modeling context and allow me to add to contemporary debates in IS research. Through a detailed analysis of them (not discussed here to conserve space), I found that an affordance lens offered the most insight and applicability. As a result, my thesis adopts an affordance lens.

Affordances are typically defined as possibilities for goal-oriented action that artifacts offer to users (Markus and Silver 2008). Research on affordances tells us that while artifacts, such as process models, have material properties that people can make use of, the existence of these properties alone does not determine their use or impact. Rather, outcomes depend on how users perceive and use the object to reach a goal (Gibson 1979). Still, key gaps remain in our understanding of affordances. The concept as used in the majority of studies so far is underdeveloped and does not fully capitalize on its capabilities in explaining the object-user relationship. In particular, IS research on affordances largely assumes that affordances simply emerge and can be utilized, without justifying how and why they emerge and what influence their actualization by users of the object. To address this gap, I will examine the emergence and actualization of affordances in the process modeling context.

## **2. Related Literature**

### **2.1. Process Modeling Impact**

Several authors have attempted to examine the impact of process modeling. Table 1 summarizes my literature review on process modeling impact. I draw three main observations from this review. First, understanding and communication describe a recurring theme of impacts from process modeling initiatives, suggesting that many impacts involve supporting stakeholder interaction with process models. Second, publications to date often report on research in progress rather than completed studies and mature theories. Certainly, no comprehensive theory has emerged that can account for process modeling impacts (RQ 1). Third, current studies often neglect the model user perspective and instead focus on the views and assessments of modelers, academics, vendors, or consultants.

*- Insert Table 1 here -*

In a first step to gain further empirical insights into process modeling impacts, I conducted a series of exploratory semi-structured interviews to examine process model use in practice. I interviewed process model users from two Australian government agencies and one private sector organization to explore the nature and complexity of impacts from process model use in practice (Bernhard and Recker 2012). While this work shed light on the impacts of process models (RQ1), I could not yet fully explain how process model use leads to the observed impacts (RQ 2).

### **2.2. Affordances**

As a next step, I conducted a review of the use of the affordances lens in IS research to help me build a theoretical model to explain the perception and actualization of process modeling affordances (Table 2) and to understand how process modeling impacts are developed (i.e., RQ 2).

*- Insert Table 2 here -*

From this review, I reached a number of conclusions. First, even though psychology researchers have highlighted the role of a user's affordance perception before being able to act on it, this conceptual separation has, with few exceptions (e.g., Strong et al. 2014), largely been ignored in IS research. Second, while the notion of affordances has experienced a wide uptake in several fields, especially psychology, the proliferation of this concept in IS has occurred only recently. The number of studies utilizing the affordances lens is still growing. Third, in terms of methodology, while there is

some empirical IS affordances research, most examined one single case or (re-) examined multiple cases. Especially applications of quantitative methods are almost non-existent. One argument might be that the affordances concept naturally lends itself more to qualitative research to avoid “impoverished descriptions” (Michaels and Carello 1981) and that quantitative methods might not be well suited to explore affordance emergence, perception and actualization. However, given the wealth of experiment research on affordances in psychology, this seems doubtful. Fourth, the characteristics of the object’s user have not been addressed appropriately in prior IS research (Markus and Silver 2008). This has been an integral part of the affordances concept since its origination in psychology and focused on those (physical) user attributes that play a key role for a certain activity, such as leg length for stair climbing (Warren 1984) or body height for sitting on a chair (Stoffregen et al. 1999).

### **3. Theory**

To address the lack of knowledge about the mechanisms that lead to process modeling impacts and to advance understanding of affordances in IS, I offer a new framework of process modeling affordances (Figure 1). The benefit of frameworks that can help shape understandings of key theoretical variables is widely acknowledged (Eisenhardt 1989). In Figure 1, boxes show the constructs in my proposed model. Layered boxes represent multiple instances of a construct, such as a range of existing affordances offered by an object to its user, or the perception of certain, but not all, existing affordances by the user of an object. The arrows indicate the temporal-causal logic relating constructs to one another, e.g., affordance perception influences and thus precedes actualization.

The main proposition of the model is that impacts from affordance actualization are determined primarily by the perception of affordances, but also influenced by the degree of effort involved in the actualization. Affordance perception is determined by the emergence of an affordance when a user interacts with an object. The available information about the emerged affordance additionally influences if, and how, a user perceives the affordance.

*- Insert Figure 1 here -*

### 3.1. The Emergence of Affordances

Because the affordances concept adopts a teleological perspective (the view that human behavior is goal-driven), and because affordances are said to emerge in the interaction of an object and its user, we must specify the *user* of the object (Turvey 1992). Even though there is disagreement among researchers as to what the relevant user properties are (Chemero 2003), most recognize that the extent to which the user of an artifact has an individual capacity for activity, what I refer to as *ability*, plays a vital role in affordance perception and actualization (Stoffregen 2000). The definition of affordances as “goal-oriented action possibilities” (Markus and Silver 2008) points to the importance of the goal that the user of an object pursues. This led me to include a user’s *goal(s)* in a given task.

In my conceptualization of the object in use, I follow Markus and Silver’s (2008) discussion of object properties. This includes material, arrangement and appearance, among others. The relevant properties from an affordance perspective are those that hold *causal potential* to lead to the occurrence of an outcome, by influencing how users interact with the object.

### 3.2. The Perception of Affordances

The link, and distinction, between affordances perception (awareness that an action possibility exists) and actualization (turning possibility into action) is unclear in the IS literature. I show how they link. Affordance perception is clearly critical: “the question is not whether affordances exist, but whether information is available for perceiving them” (Gibson 1979). Later work by McGrenere and Ho (2000) confirmed this view. Important papers in this tradition include Gaver’s (1991) analysis that identified three categories of affordances (perceptible, hidden, false), and Shaw’s et al. (1982) analysis of how affordances can be misperceived and that users may not realize this until after an unsuccessful attempt of affordance actualization.

Thus, my model suggests that affordance perception is influenced by *information about affordances*, i.e., cues that signal to a user that an affordance exists. One source of affordance-related information is the object itself, i.e., its *symbolic expressions*. Symbolic expressions are the messages that an artifact communicates to its user (Markus and Silver 2008). *External information* is another source of affordance information. I make this distinction because symbolic expressions originate from the object while external information does not require the object’s presence. My approach deviates

from authors who classify both information sources as symbolic expressions (e.g. Goh et al. 2011). I believe that the latter approach oversimplifies the expressive power of the affordances concept.

Perceived affordances are not the same as existing affordances. Perceived affordances can for example be a subset (i.e., not all existing affordances are perceived by the user) or a different set altogether (i.e., the user falsely perceives affordances which actually are not present).

Affordances do not necessarily determine action but rather define a set of possible actions (Markus and Silver 2008). Thus, after affordance perception, the user engages in a (conscious or unconscious) decision-making process about whether to actualize an affordance (Warren 1988) or, in case of multiple perceived affordances, which specific affordance to actualize (Ye et al. 2009). Importantly, the actualization decision of a user may, but does not necessarily, correspond to the originally intended use of the object (Orlikowski 1992). The actualization decision is based on the goals of the user and the anticipated impact of actualizing an affordance (Newell 1982).

### **3.3. The Role of Effort in Affordance Actualization**

Several authors argue that the actualization of an affordance is influenced by the degree of *effort* the user of an object has to invest. McGrenere and Ho (2000) found that affordance actualization is not possible or impossible but instead a continuum with different degrees of difficulty. Similarly, Warren (1984) stated that affordances are positioned in a space framed by a critical point below which the actualization of an affordance is not possible and an optimal point which marks the least amount of effort for affordance actualization. This latter point represents the most efficient affordance fit between user and object. I posit that actualization of a perceived affordance is a function moderated by perceptions of the effort that it takes to actualize the affordance. Put simply, the question is “how hard would it be to execute the action that the object allows me to pursue?”

Table 3 summarizes the framework components and illustrates the concept using a scenario of process model users facing a requirements specification task.

- Insert Table 3 here -

## 4. Research Design

My framework of affordance emergence, actualization, and downstream impacts highlights three key attributes that determine the choice of research design. First, the model distinguishes the emergence, perception, actualization and impact of affordances as a process that occurs over time. A requirement to examine this aspect of the model is thus to employ a longitudinal research design. Second, the model suggests that material (e.g., process model) properties plus information about affordance existence will predict whether individuals are able to perceive and subsequently actualize affordances. To examine this logic, a research design must be chosen that allows manipulation and control. Third, the research method must be capable of examining, for instance, misperception or a lack of perception of affordances which is not possible when relying solely on perceptual data as reported by informants. This objectivity aspect is essential when studying affordances, as this concept requires a holistic view of the object-user relationship.

Prior studies using the affordances lens, if being empirical at all, have largely focused on qualitative research methods such as single case studies (see Table 2). This is a suitable method to closely examine the emergence, actualization, and impacts of affordances over time. Other work outside of IS conducted experiments to assert control over a setting and find evidence for specific links, e.g. the role of effort in affordance actualization (Warren 1984). I argue that the model proposed here can best be examined through an iterative, full-cycle research approach (Chatman and Flynn 2005) on the basis of a mixed method design (Tashakkori et al. 2012; Venkatesh et al. 2013), combining quantitative experiment data with qualitative case study data (Figure 2).

Specifically, I propose a four-step process: (1) observations of process model use and affordances in a realistic case setting as a starting point for my research to ensure relevance and natural proof, and informing the complexity of my constructs (such as affordance perception and actualization), (2) theorizing efforts around the constructs and their causes, (3) experimental examination of process modeling affordances to identify causal relationships and boundary conditions, and (4) additional observations in the field to increase my understanding and support further theorizing (Chatman, Flynn 2005). The benefits of such a design will include complementarity (i.e., gaining complementary views about how affordances from process modeling emerge, are perceived,



actualized and lead to certain impacts), completeness (i.e., making sure a complete picture of process modeling affordances is acquired), confirmation (i.e., evaluating the credibility of inferences gained from case study and experiments), and compensation (i.e., compensating for the limitations of the case study by using experiments and vice versa).

*- Insert Figure 2 here -*

In my own ongoing work, I thus design two interlinked studies that I now describe briefly.

#### **4.1. Case Study**

An organization from the financial service sector acts as case partner. The timeframe is February to December 2014. The task setting under examination was the creation and use of process models within a system development project. The primary goal of the project is to integrate different divisions and products into one system after a period of organic and inorganic growth. The study consists of two phases. First, I studied the model design activities of a team of eight employees to capture system requirements. Following this, I am currently studying two IT teams using process models to develop financial and reporting solutions as well as the user interface.

Means of data collection are semi-structured interviews with model users to capture perceptual data, analysis of documents (especially the process models being used) and observations of instances of process model use. Additionally, I am also spending time with employees who do not use or are even skeptical towards process models to identify further factors that potentially obstruct affordance actualization.

The protocol to guide the interviews contains four main parts. The first part is about demographic information. Second, I ask questions relating to modeling experience and expertise and levels of exposure to and utilization of process models in the workplace. Third, I inquire about actions enabled by a certain process model as utilized in a work task, including detailed questions about the context and situation in which a process model supported a certain kind of behavior and what the process model allowed the respondent to do. Fourth, I ask about the key details, such as properties of the used process model, to establish a link from model properties to affordances and impacts. The retrospective accounts given by interviewees are challenged using other data collection means, e.g., statements by respondents relating to model properties are compared to insights from analyzing the

corresponding process model, and reported action-possibilities are compared to observed actions and behaviors enabled by the process model.

I am analyzing the data using coding techniques associated with grounded theory (Corbin and Strauss 2008; Urquhart et al. 2010). Unlike grounded theory, however, I had a general preconception of process modeling affordances when I initiated my study, which naturally guided my data collection instruments and focus of study. During open coding, I am focusing on recurring and interesting themes. During axial coding, I am using the main concepts and relationships of affordance theory (e.g., action-possibilities, object / user characteristics) as dimensions of the emerging themes. During selective coding, I am identifying theoretical patterns, recognized as affordances, through constant comparison (e.g., the recurring use of process models as information sources to guide specific aspects of software development, such as finding the appropriate labels for system fields as part of the user interface, or guiding user actions via system restrictions based on desired behaviors that are explicated in the models).

#### **4.2. Experiment Study**

In the experiment I tested one key link of the affordances concept: the perception and actualization of affordances. This focus is justified by the prominence of this logical chain to the model of the affordance actualization process (Figure 1). I opted for a mixed design, with the two-level *between-group* factor symbolic expressions (process model with and without swim lanes), the three-level *between-group* factor external information (correct, incorrect, and irrelevant external information), and four *within-subject* factors (user ability, goal-orientation, and affordance actualization effort). The rationale is that this leads to the emergence and (mis-)perception of a task allocation affordance – the possibility to allocate tasks to process participants.

Participants were randomly assigned to groups. The procedure was as follows: First, after an introduction text that briefly explained the study and its aims, descriptive statistics and control variables were obtained (e.g., domain knowledge, self-efficacy). I also queried participants' goal-orientation. Second, I assessed participants' modeling ability. Third, participants received a process model and external information as treatment. The materials remained available to participants from this point (Parsons and Cole 2005). After instructing participants to study the materials carefully, I assessed participants' comprehension of the model. Fourth, I measured participants' affordance

perception. Fifth, participants completed two problem-solving tasks. Sixth, participants were asked how much they relied on various information sources in completing the tasks. In addition, participants' recorded the extent to which they experienced cognitive load during the tasks.

## 5. Expected Contributions

This research increases our understanding of process modeling impacts and proposes a novel way to theorize about affordances. Although empirical studies of the affordances concept in the IS discipline are growing, it is still under-researched. My research will be amongst the first in IS to distinguish between affordance perception and actualization as well as explain the role of object and user characteristics in the emergence of affordances, and how this leads to impacts.

To the best of my knowledge, this study is also the first attempt to theorize about and examine *process modeling* affordances. My framework can help in the identification of relevant process model properties that possess causal potential for affordances to emerge for users of that model. I can further elucidate the role of the model user's characteristics – such as modeling ability – and thereby point to the importance of model user education and training. By examining the perception and actualization of process model-related affordances, I can help organizations to use process models effectively, i.e., to actualize perceptible affordances, avoid false affordances, and uncover hidden affordances.

Finally, as a methodological contribution, I will demonstrate the use of a full-cycle, mixed method study around affordances and impacts, in contrast to prior empirical affordances research that has largely focused on the qualitative examination of a single case alone.

## 6. Expected Limitations

My study has several limitations. First, while an affordance lens can be useful, any lens is partial and fallible. Other relevant lenses/theories could be tried. Second, even though affordance theory seems quite applicable to process modeling, it may inhibit the generalizability of my arguments (e.g. to other contexts such as ERP systems). Third, my methods are also limited. Generalization from a case study is difficult (Kerlinger 1986) and observations and interviews can be artificial and intrusive (Myers and Newman 2007). Experiments are also artificial. Nevertheless, they allow me the ability to control for influencing factors besides the treatment. Thus, my thesis involves tradeoffs of internal and external validity, but I am seeking to obtain a reasonable balance of the two.

## **7. Conclusions**

Overall, my thesis seeks to characterize the impacts that stem from the use of process models, and to develop a framework of affordance emergence, perception and actualization to explain how these impacts occur. I explain causality specific to the process modeling context, but at the same time I feel my proposed framework is sufficiently generalizable beyond this application area to be of value for other areas of IS research and potentially also for other fields that involve the use of objects.

## Tables and Figures (ordered as they appear in the text)

| Author(s)                                  | Selected Key Findings   | Modeling Impact  |
|--|---|--|
| Kesari et al. (2003)                       | Process modeling leads to documentation, design, and use benefits.  | <ul style="list-style-type: none"> <li>• Communication</li> <li>• Understanding</li> <li>• Improvements</li> </ul>     |
| Aguilar-Savén (2004)                       | Process modeling enables a common understanding and analysis of a business process and support communication.   | <ul style="list-style-type: none"> <li>• Understanding</li> <li>• Communication</li> <li>• Process Analysis</li> </ul> |
| Danesh and Kock (2005); Kock et al. (2009) | Process redesign success is influenced by process model communication and information flow orientation (for high quality models).                           | <ul style="list-style-type: none"> <li>• Communication</li> </ul>  |
| Davies et al. (2006)                       | Process model use leads to effective stakeholder communication and a better understanding of models' integration into business processes.                   | <ul style="list-style-type: none"> <li>• Communication</li> <li>• Understanding</li> </ul>                             |
| Krogstie et al. (2008)                     | Process modeling leads to increased communication, creation of a common frame of reference, improved understanding of processes and of other group members. | <ul style="list-style-type: none"> <li>• Communication</li> <li>• Understanding</li> </ul>                             |
| Indulska et al. (2009)                     | Process modeling leads to an increased ability to improve processes, improved understanding of processes, and improved communication across stakeholders.   | <ul style="list-style-type: none"> <li>• Improvements</li> <li>• Understanding</li> <li>• Communication</li> </ul>     |

Table 1. Key Modeling Impact Literature.

| References             | Key Findings  | Methodology                           | Contributions to the Understanding of Affordances  |
|------------------------|---|---------------------------------------|--|
| Markus, Silver (2008)  | <ul style="list-style-type: none"> <li>• Object properties are relevant but insufficient to explain object uses and effects.</li> <li>• Object properties can provide affordance information, but affordances are not object properties.</li> </ul>                       | Conceptual study                      | Functional affordances and symbolic expressions as relational concepts describe IT artifacts.                                |
| Leonardi (2011)        | <ul style="list-style-type: none"> <li>• Technology either constrains or affords employee goal achievement.</li> <li>• Depending on the imbrications of human and material agencies, employees change routines or technologies when failing to achieve a goal.</li> </ul> | Single case study                     | Change decisions are based on the imbrications of human and material agencies.   |
| Goh et al. (2011)      | <ul style="list-style-type: none"> <li>• Co-evolution of routines and technology: Affordances of new system change organizational routines; new system is routinized.</li> </ul>  | Single case study                     | Evolution of affordances through agentic action.   |
| Volkoff, Strong (2013) | <ul style="list-style-type: none"> <li>• Affordance-based theories informed by critical realism enhance our ability to explain IT-associated organizational change.</li> </ul>  | Post-hoc analysis of two case studies | Affordances are generative mechanisms in organizational change processes.  |
| Robey et al. (2013)    | <ul style="list-style-type: none"> <li>• Material artifacts are part of a generative system that leads to organizational change.</li> </ul>   | Conceptual study                      | Conceptualization of organizational change affordances at the organizational level.  |
| Leonardi (2013)        | <ul style="list-style-type: none"> <li>• Group-level network change leads to changes on the organizational level when individuals use the same subset system features.</li> </ul>   | Single case study                     | The use of the same system features by different individuals leads to the emergence and actualization of shared affordances. |

|                       |   |   |  |
|-----------------------|---|---|--|
| Strong et al. (2014)  | <ul style="list-style-type: none"> <li>Research should address the IT artifact, the process of IT effects, the multi-level nature of IT-enabled change processes, and the intentionality of change agents.</li> </ul> | Single case study   | Replacement of appropriation concept with actualization.   |
| Jung, Lyytinen (2014) | <ul style="list-style-type: none"> <li>Media choice is a multi-dimensional process, based on media features and voluntaristic rendering of users' media perceptions.</li> </ul>                                       | Multiple case study   | Users explore their surroundings to establish affordances that allow goal achievement.                       |
| Gaskin et al. (2014)  | <ul style="list-style-type: none"> <li>Development of a lexical framework to study generalizable patterns of association in socio-material practices.</li> </ul>  | Conceptual study illustrated using qualitative and sequence analysis of a single case | The affordances and materiality of affordances offered by an object are elements of socio-material routines. |

Table 2: Existing Information Systems Research on Affordances.

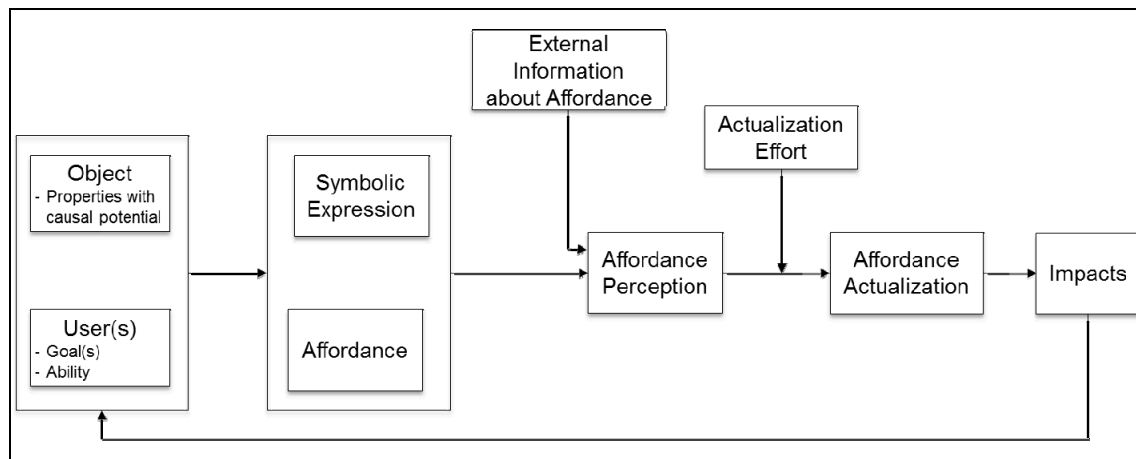


Figure 1. A Model of Affordance Perception and Actualization (based on Bernhard et al. 2013).

| Construct                    | Dimensions  | Description   | Relevant Literature   | Illustration in the Process Modeling Context   |
|------------------------------|---|---|-----------------------|--|
| Object                       | <ul style="list-style-type: none"> <li>Properties with causal potential to incur affordances</li> </ul> | An object employed by an individual in a goal-directed activity.  | Markus, Silver (2008) | Anna is provided with a process model that provides process details such as activities, events, roles, data inputs and outputs. Tom is provided with a data model that specifies data entities and associations. Both face a comparable procedural software requirement specification work task. |
| User                         | <ul style="list-style-type: none"> <li>Goal(s)</li> <li>Ability</li> </ul>                              | An individual who employs an object to perform a goal-directed activity.  | Markus, Silver (2008) |  |
| Information about Affordance | <ul style="list-style-type: none"> <li>Symbolic expressions</li> <li>External information</li> </ul>    | <ul style="list-style-type: none"> <li>Properties that communicate affordances</li> <li>Information about affordances from sources other than the object itself.</li> </ul> | Markus, Silver (2008) | The model communicates its suitability for requirement specification through labeling and annotation. Anna informs Tom about the procedural requirement specification opportunity offered by his model.  |
| Affordance Perception        | <ul style="list-style-type: none"> <li>Degree of affordance perception</li> </ul>                       | The perception of a possibility for goal-oriented action afforded by an object for a user.  | Shaw et al. (1982)    | Anna perceives the procedural requirement specification affordance using her model, while Tom falsely thinks he can produce SQL queries from his model.  |

|                          |   |   |   |   |
|--------------------------|---|---|---|---|
| Affordance Actualization | <ul style="list-style-type: none"> <li>Actualization decision</li> </ul>                                    | The actualization of a possibility for goal-oriented action afforded by an object for a user. | Markus, Silver (2008); Strong et al. (2014) | Anna and Tom both start to specify the procedural requirements of the software using the process model.                   |
| Actualization Effort     | <ul style="list-style-type: none"> <li>Cognitive load</li> </ul>  | The degree of difficulty related to actualizing an affordance.                                | McGrenere, Ho (2000)                        | Specifying the procedural software requirements using the model is easy for Anna, but difficult for Tom.                  |
| Impact                   | <ul style="list-style-type: none"> <li>Level</li> <li>Timeframe</li> <li>Phase</li> <li>Duration</li> </ul> | The value-neutral use effects attributed to the actualization of an affordance.               | Seddon (1997)                               | The suggested specified procedural requirements for software development made by Anna and Tom based on the process model. |

Table 3. Framework Constructs and Definitions (based on Bernhard et al. 2013).

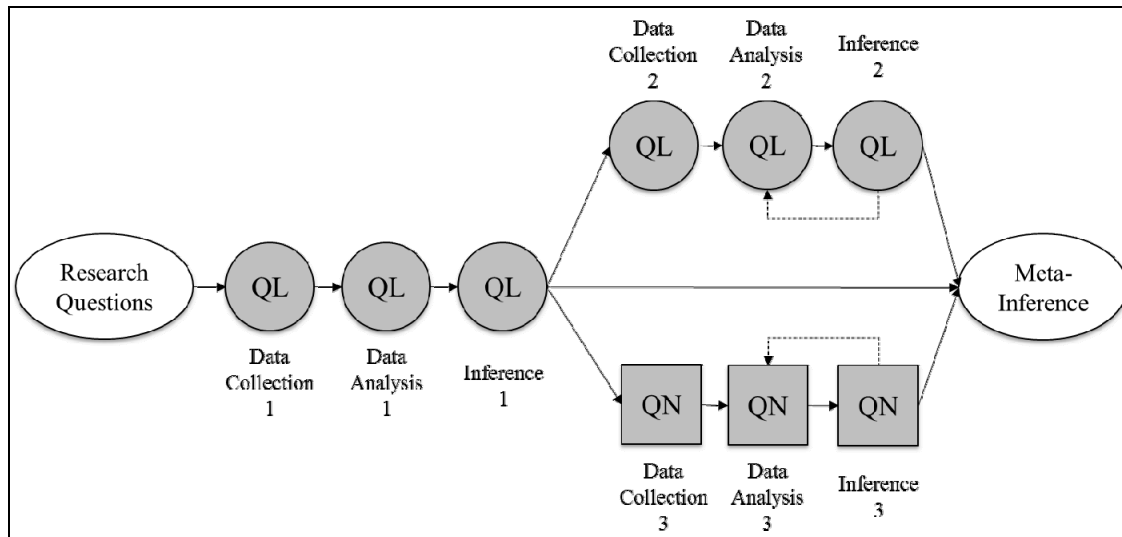


Figure 2. Sequential (1) and Parallel (2 and 3) Mixed Methods Design (QL = qualitative, QN = quantitative, dashed lines represent feedback; based on the notation of Tashakkori et al. 2012).

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